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## *On an Annual Variation in the R−D Discordance.*

### By H. H. Turner, M.A., B.Sc.

In connection with a discussion of the distribution of temperature in the Transit Circle Room at the Royal Observatory, Greenwich, it occurred to me to inquire whether the R−D discordance varies during the year. Such a variation might be an indication of the dependence of part, or the whole, of the discordance upon the temperature distribution. The major part of the discordance is usually ascribed to flexure of the instrument; and in the case of the Greenwich Transit Circle the closeness with which the law of the sine zenith-distance satisfies the observations certainly points to the probability of this hypothesis. But there is a curious anomaly in the fact that whereas the horizontal flexure thus indicated would be nearly 1″, observations made with the collimators in the ordinary way give a very small horizontal flexure.

It has further been noticed that the residuals of R—D, after comparing the actual observations with this assumed simple law, are persistent in sign year after year at the same zenith-distance, and suggest a secondary discordance not included in the assumed formula. The R—D may in fact be a complex phenomenon, and part of it at least may be due to other causes than flexure. This remark will now be illustrated by a discussion of the residuals for the years 1883–1890, during which the principal (flexure) term of the R−D has remained sensibly constant. Previously to 1883 the range of stars available in reflexion observations was much more restricted, owing to the mounting of the collimators, and the results are thus not so readily comparable. In the years 1883–1890 the results have been grouped in as nearly as possible the same manner; and the mean of the residuals for corresponding groups is given opposite the approximate mean Z. D. of the group.

*Mean Residuals of R−D for Years* 1883–1890.

| Mean. Z.D. | North Stars. | South Stars. | N−S. | Mean Z.D. | North Stars. | South Stars. | N−S. |
|---|---|---|---|---|---|---|---|
| ° | ″ | ″ | ″ | ° | ″ | ″ | ″ |
| 68½ | +0·40 | −0·83 | +1·23 | 36 | +0·24 | +0·36 | −0·12 |
| 65½ | +0·36 | −0·24 | +0·60 | 30 | +0·05 | +0·38 | −0·33 |
| 62 | −0·24 | −0·32 | +0·08 | 26 | +0·03 | +0·25 | −0·22 |
| 59 | −0·55 | −0·18 | −0·37 | 24 | 0·00 | +0·07 | −0·07 |
| 56 | −0·25 | −0·28 | +0·03 | 20 | +0·02 | +0·08 | −0·06 |
| 52 | +0·18 | −0·0 | +0·24 | 16½ | +0·06 | ... | ... |
| 48 | +0·02 | −0·06 | +0·08 | 12½ | +0·18 | −0·22 | +0·40 |
| 42 | +0·31 | +0·18 | +0·13 | 9½ | +0·23 | ... | ... |

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From accurate measurements recently made, it appears that in reflexion observations made at zenith-distances less than 21° or greater than 62° the full aperture of the telescope objective is not used, and hence the corresponding groups should be excluded from the present discussion. From the intermediate groups it will be seen that both for N. and S. stars the residuals are negative for large zenith-distances and positive for small, though the change takes place earlier for N. stars than for S. A smooth curve shows a secondary discordance amounting to at least $0''\cdot5$ not included in the standard formula. It is under consideration whether this discordance may not be due to the fact that the direct and reflected rays do not strike the general mass of air in the observing room at the same point, and may suffer different refractions: the difference possibly varying with the time of year.

But the immediate object of the present note is to point out that the R—D discordance is subject to an annual fluctuation, whatever the cause. For this purpose little more is necessary than to print the following table of results, obtained as follows:—The whole of the observations 1883–1890 were collected and divided into groups according to the month of the year, retaining the cross grouping in zenith-distance; in fact, the subdivision into twelve months is merely substituted for that into eight years, so that we have in each monthly group about two-thirds of the number of stars formerly found in each annual group, and the material for determining the R—D for any month is comparable with that usually employed for the annual determination. In one or two cases where there was no star in a particular group, a mean value for that group has been adopted from neighbouring groups, and the result enclosed within brackets.

*Mean R − D Discordance for each Calendar Month in the Years 1883–1890.*

*North Stars.*

| Mean N.P.D. of Group. | Mean Z.D. of Group. | Jan. | Feb. | Mar. | April. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ° ′ | ° ′ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ |
| −29·0 | −67·30 | +0·06 | −0·94 | −1·04 | −1·67 | −0·75 | −1·06 | −1·56 | −0·80 | −0·38 | −0·57 | −0·23 | −0·44 |
| −27·0 | −65·30 | −0·97 | −0·90 | −1·38 | −1·24 | −1·11 | −1·03 | −0·96 | −0·73 | −3·43 | −0·77 | −0·54 | −0·58 |
| −25·0 | −63·30 | −1·63 | −1·55 | −1·11 | −1·20 | −2·22 | −2·15 | −1·22 | −1·45 | −1·03 | −1·04 | −1·35 | −1·05 |
| −23·0 | −61·30 | (−1·62) | −0·90 | −1·27 | −1·82 | −1·30 | −1·79 | −1·67 | −1·23 | −0·47 | −1·02 | −0·86 | +1·31 |
| −20·30 | −59·0 | −1·60 | −1·89 | −1·82 | −1·75 | −2·03 | −1·87 | −0·89 | −0·93 | −1·11 | −1·67 | −1·48 | −1·67 |
| −17·0 | −55·30 | −1·58 | −0·38 | −0·64 | −1·27 | −1·38 | −1·45 | −1·47 | −1·16 | −1·01 | −1·53 | −1·04 | −1·24 |
| −13·0 | −51·30 | −0·52 | −1·12 | +1·35 | −1·01 | −0·44 | −1·03 | −1·28 | −0·45 | −0·91 | −1·01 | −0·48 | −1·09 |
| − 8·30 | −47·0 | −1·50 | −1·08 | −1·02 | −1·29 | −1·57 | −0·80 | −1·81 | −0·73 | −0·63 | −0·96 | −0·61 | −0·66 |
| − 3·0 | −41·30 | +0·01 | −0·22 | −0·88 | −0·12 | −0·35 | −0·77 | −0·54 | −0·53 | −0·42 | −0·46 | −0·58 | −0·48 |
| + 3·0 | −35·30 | −0·11 | −0·38 | −0·01 | −1·53 | −0·57 | −0·92 | −0·76 | −0·94 | −0·69 | −0·40 | −0·52 | −0·86 |
| + 8·30 | −30·0 | −0·09 | −0·51 | −0·45 | −0·29 | −0·78 | −0·47 | −0·36 | −0·72 | −0·43 | −0·50 | −0·46 | −0·85 |
| +14·0 | −24·30 | −0·68 | +0·19 | +0·07 | −0·46 | −1·01 | −0·65 | −0·51 | −0·33 | −0·75 | −0·88 | −0·56 | −0·36 |
| +18·30 | −20·0 | −0·78 | +0·28 | +0·37 | −0·76 | −1·38 | −1·12 | −0·87 | −0·54 | −0·59 | +0·15 | −0·68 | −0·30 |
| +22·0 | −16·30 | +0·63 | +0·47 | −0·44 | −0·62 | −0·39 | −0·55 | −0·45 | −0·47 | −0·13 | −0·46 | −1·04 | −0·03 |
| +25·0 | −13·30 | −0·53 | +0·19 | −0·12 | −0·04 | −0·47 | −0·73 | −0·14 | +0·45 | −0·06 | +0·31 | −0·45 | −0·68 |
| +33·0 | − 5·30 | −0·48 | +0·84 | +0·15 | −0·12 | −0·48 | −0·33 | +1·95 | −0·09 | −0·04 | +0·20 | +0·36 | +0·41 |

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*South Stars.*

| Mean N.P.D. of Group. | Mean Z.D. of Group. | Jan. | Feb. | Mar. | April. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ° ′ | ° ′ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ |
| + 46·0 | + 7·30 | +0·52 | +0·71 | −0·54 | +2·72 | −0·34 | +0·99 | +0·66 | +0·22 | −0·79 | +0·23 | −0·38 | −0·51 |
| + 57·0 | +18·30 | +0·42 | −1·04 | +0·78 | +0·52 | +0·17 | +0·30 | +0·78 | +0·30 | +0·49 | +0·22 | +0·23 | +1·17 |
| + 62·30 | +24·0 | −0·27 | +0·95 | +0·47 | −0·03 | −0·05 | +0·84 | +0·49 | +0·37 | −0·46 | +0·59 | +0·05 | +0·31 |
| + 65·30 | +27·0 | +0·67 | −0·12 | +0·06 | +0·41 | +0·50 | −0·16 | +0·57 | +0·08 | +0·09 | +0·48 | +0·20 | +0·01 |
| + 68·30 | +30·0 | +0·44 | +0·12 | +0·11 | +0·69 | +0·32 | −0·91 | +0·49 | +0·35 | +0·25 | +0·98 | −0·10 | +0·13 |
| + 72·0 | +33·30 | +0·34 | +0·32 | +0·18 | +0·58 | +0·19 | +0·37 | −0·11 | +0·31 | +0·13 | +0·36 | +0·48 | +0·27 |
| + 76·0 | +37·30 | +1·42 | +0·06 | +0·07 | +0·16 | +0·69 | +0·52 | +0·57 | +0·42 | +0·54 | +0·05 | +0·23 | +0·19 |
| + 81·0 | +42·30 | +0·20 | +0·19 | +0·29 | +0·66 | +0·46 | +0·94 | +1·12 | +0·61 | +0·53 | +0·41 | +0·73 | +0·41 |
| + 86·0 | +47·30 | +0·42 | +0·71 | +0·96 | +0·97 | +1·29 | +0·73 | +1·04 | +0·37 | +0·44 | +0·72 | +1·28 | +1·41 |
| + 90·0 | +51·30 | +0·75 | +0·77 | +0·52 | +1·09 | +1·39 | +0·78 | +0·98 | +1·54 | +0·87 | +1·01 | +0·87 | +0·56 |
| + 94·0 | +55·30 | +0·25 | +0·98 | +0·55 | +0·74 | +0·95 | +1·97 | +1·45 | +1·23 | +1·07 | +1·95 | +1·13 | +0·96 |
| + 97·30 | +59·0 | +0·22 | +0·83 | +1·64 | +1·51 | +1·38 | +1·14 | +1·35 | +0·66 | +0·64 | +1·62 | +1·39 | +2·44 |
| +100·15 | +61·45 | +0·47 | +1·14 | +0·86 | +1·59 | +1·30 | +1·53 | +1·32 | +1·72 | +1·08 | +1·46 | +0·61 | +1·44 |
| +103·15 | +64·45 | −0·02 | +1·42 | +1·53 | +1·82 | +1·98 | +1·53 | +1·23 | +1·15 | +1·05 | −0·09 | +0·76 | (+0·63) |
| +107·0 | +66·30 | +1·83 | +2·19 | +1·95 | +1·99 | +2·12 | +2·40 | +2·26 | +1·63 | +1·54 | +1·15 | +1·34 | −0·17 |

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If we assume the expression $a + b \sin$ Z. D. for the discordance, and determine by least squares the values of $a$ and $b$ for each month, we obtain the following values:—

| | $a$ | $b$ |
|---|---|---|
| | ″ | ″ |
| January ... ... | −0·01 | +0·97 |
| February ... ... | −0·01 | +0·93 |
| March ... ... | −0·01 | +1·13 |
| April ... ... | −0·04 | +1·29 |
| May ... ... | −0·11 | +1·49 |
| June ... ... | −0·09 | +1·47 |
| July ... ... | −0·07 | +1·37 |
| August ... ... | −0·06 | +1·22 |
| September ... ... | −0·04 | +1·14 |
| October ... ... | −0·06 | +1·12 |
| November ... ... | 0·00 | +1·09 |
| December ... ... | −0·04 | +0·99 |

Showing a well-marked inequality in $b$ of 0″·6. The cause of this inequality is at present the subject of further investigation.

## *The Apparent Places of Close Polar Stars.*

By A. M. W. Downing, M.A.

In the *Monthly Notices*, vol. l., pp. 357–359, Mr. Turner calls attention to certain discordances in the apparent places of polars, as given in the different Ephemerides for 1891 and some preceding years. As modifications have been introduced both into the *Connaissance des Temps* and into the *Nautical Almanac* since the publication of Mr. Turner's note, I have thought that it would be worth while communicating to the Society the results of comparisons of the apparent right ascensions of *Polaris*, λ *Ursæ Minoris*, and σ *Octantis*, as given in the *Connaissance des Temps* and *Nautical Almanac* for 1894, as well as of the apparent right ascensions of the two first-named stars as given in the *Berliner Jahrbuch* and in the *American Ephemeris*, with those of the *Nautical Almanac* for the same year. As the *Berliner Jahrbuch* for 1894 had not reached me when this work was undertaken, the method of procedure followed was to compare the places in the *Berliner Jahrbuch* for 1893 with those of the *Connaissance des Temps* for the same year, and from the results of the comparison of the places in the latter publication with those of the *Nautical Almanac* for 1894 to deduce the differences of places of the *Berliner Jahrbuch* and of the *Nautical Almanac*. It may be remarked that no change was